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Remedial Project Manager
USEPA Region 5
77 West Jackson Boulevard (SR-6J)
Chicago, IL 60604-3507

Subject:
Risk Assessment Framework
Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site

Date:
June 30, 2008

Dear Mr. Saric:

On behalf of the Kalamazoo River Study Group (KRSG), please find enclosed the Risk Assessment Framework for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. This Risk Assessment Framework has been approved by USEPA on June 19, 2008.

Sincerely,

ARCADIS

Michael J. Erickson, P.E.
Associate Vice President

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Risk Assessment Framework

Kalamazoo River Study Group

June 2008

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Allied Paper, Inc./Portage Creek/
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Supplemental Remedial Investigations/
Feasibility Studies

Risk Assessment Framework

Kalamazoo River Study Group

June 2008

ARCADIS

Michael J. Erickson, P.E.
SRI/FS Project Coordinator

Risk Assessment Framework

Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site

Supplemental Remedial
Investigations/Feasibility Studies

Prepared for:
Kalamazoo River Study Group

Prepared by:
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B0064524.00761

Date:
June 30, 2008

Table of Contents

1. Introduction **1-1**

1.1 General Approach 1-2

1.2 Risk Assessment Objectives and Overall Process 1-3

1.3 Constituent of Concern 1-4

1.4 Risk Assessment Framework Organization 1-4

2. Baseline ERA Framework **2-1**

2.1 Use of Existing Information and Data 2-1

2.2 General Baseline ERA Process 2-2

3. Baseline HHRA Framework **3-1**

3.1 Use of Existing Information and Data 3-1

3.2 General Baseline HHRA Process 3-1

4. Assessing Risks Associated with Remedial Alternatives **4-1**

5. References **5-1**

Figure

1-1 Areas of the Site

1. Introduction

On February 21, 2007 Georgia-Pacific Corporation and Millennium Holdings, LLC—collectively referred to as the Kalamazoo River Study Group, or KRSG—voluntarily entered into an Administrative Settlement Agreement and Order on Consent (AOC) with the U.S. Environmental Protection Agency (USEPA) that will govern the majority of work from this point forward at the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site (Site or Superfund Site), located in Kalamazoo and Allegan counties in southwest Michigan (Figure 1-1). This agreement describes a series of activities associated with supplemental remedial investigations and feasibility studies (SRIs/FSs) that will be carried out over the next several years in Operable Unit 5 (OU5) of the Site (SRI/FS AOC; Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. V-W-07-C-864). OU5 encompasses 80 miles of the Kalamazoo River, including a stretch of Portage Creek from Alcott Street to its confluence with the Kalamazoo River.

As part of the SRI/FS activities, KRSG will prepare ecological and human health risk assessments for the geographical Areas of OU5 defined in the Statement of Work (SOW) included as Attachment A to the SRI/FS AOC. To guide the risk assessment work and provide for consistency and efficiency across the Areas, the SOW outlines requirements for the baseline ecological risk assessments (ERAs) and human health risk assessments (HHRAs). Specifically, the SOW requires the development of a Risk Assessment Framework that will serve as the basis for performing the Area-Specific baseline ERAs and HHRAs.

This RA Framework was developed to establish the process for implementing Area-specific risk assessments. The existing USEPA-approved risk assessments performed by Camp Dresser & McKee (CDM) (CDM 2003a and 2003b) will serve as a point of departure for risk assessments in each Area. A risk assessment work plan will be prepared for each Area (as part of the SRI/FS work plans called for by the SOW[1]) that will establish what (if any) aspects of the CDM risk assessments will be revisited to prepare Area-specific risk assessments, and the basis for the proposed updates. The work plans will also describe if and how results of the ecological studies conducted by researchers at Michigan State University (MSU) on behalf of the KRSG will be incorporated in the ecological risk assessment for each Area[2]. At a minimum, updated risk calculations are anticipated to be performed for each Area by incorporating more recent exposure data (e.g., new measurements of polychlorinated biphenyl (PCB)

[1] Since the Area 1 SRI/FS Work Plan has already been submitted to and approved by USEPA, a separate Risk Assessment Work Plan will be prepared and submitted to USEPA for Area 1 on or before June 30, 2009.

[2] The MSU studies are currently undergoing a peer review process to assess their assess their quality and utility as additional lines of evidence for evaluating potential ecological risk at the Site and informing risk management decisions.

concentrations in soil, sediment, water, or fish). In conducting future Area-specific risk assessment work, the basis for changes from the CDM risk assessment methodology or inputs may also include the incorporation of new data, new science, new guidance, or new methodologies acceptable to USEPA that are current at the time each work plan is prepared. This RA Framework does not specify what methodology, information, or findings from existing USEPA-approved risk assessments will or will not be used by KRSG to prepare Area-specific risk assessments. Detailed aspects of the approach and methodology will be provided in the work plans for each of the Area-specific risk assessments, and USEPA will have the opportunity to review each work plan before issuing a final approval. By approving this RA Framework, USEPA is neither approving nor ruling out use of any particular risk assessment data, science, guidance, or methodology in Area -specific risk assessments to be performed at the Site.

This RA Framework is developed to be general and flexible to be applicable to all Areas of the Site over the time during which SRI/FS activities are conducted under the AOC and SOW.

1.1 General Approach

KRSG will prepare risk assessment work plans for each Area as part of the SRI process. Based on the approach described in the work plans, Area-specific baseline risk assessments will be provided to USEPA as attachments to Area-specific SRI reports for review and approval, unless risk assessments previously approved by USEPA are to be used, in which case that approach would be indicated in the work plan for that Area.

Area-specific risk assessments will build upon the information presented in the existing USEPA-approved CDM risk assessments (CDM 2003a and 2003b) and the *Generalized Conceptual Site Model for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site* (Generalized CSM; ARCADIS 2008), incorporating new data and refining the exposure assumptions and Generalized CSM as appropriate based on Area-specific considerations, such as unique habitats and differences in human use, or other considerations. Each baseline risk assessment will include an Area-specific exposure assessment, toxicity assessment, and risk characterization for both human and ecological receptors.

The USEPA-approved risk assessments performed by CDM will be used as the basis for developing each Area risk assessment work plan, unless an alternate risk assessment methodology previously approved by USEPA in an Area-specific work plan or risk assessment is more appropriate. In that case, the approved methodology will be carried forward by reference. In the interest of streamlining the process, for some Areas KRSG may propose little or no additional risk assessment work and may instead rely upon either the USEPA-approved

CDM risk assessment work and/or USEPA-approved risk assessment work for other Areas in whole or in part. Area-specific risk assessments may be completed by referencing relevant prior USEPA-approved risk assessment work (either the CDM reports or another Area-specific assessment) and updating or revisiting only those factors that are unique to the Area in question.

Details such as the receptor populations, exposure scenarios, exposure factor values, and toxicity criteria to be included in each Area-specific risk assessment will be described in the Area-specific risk assessment work plans and determined based on available Site-wide and Area-specific information, including data collected as part of the SRI/FS process.

In the Area-specific risk assessment work plans, the assessment of ecological risks associated with exposure to floodplain soils within formerly impounded areas along the Kalamazoo River will be developed based on the results of the Peer Review process that is being carried out under the SOW. If the Peer Review Panel concludes that results from the MSU studies should not be used for risk assessment, the KRSG will not propose to use that information. If the Peer Review results are inconclusive, the Area-specific work plans will propose how to accommodate that result. If the Peer Review Panel concludes that the MSU studies should be considered as additional lines of evidence for evaluating potential ecological risk at the Site and informing risk management decisions, each Area-specific risk assessment work plan will specify a methodology for incorporating results of the MSU studies. If the methodology to be proposed for an Area has been approved by USEPA for a prior Area-specific work plan or risk assessment, then the approved methodology will be carried forward by reference. In Area-specific work plans the KRSG may also present, as additional lines of evidence, new ecological information or studies available since the 2003 CDM ERA was prepared that were not part of the Peer Review, if applicable to conditions in that Area.

The Area 1 Risk Assessment Work Plan will be prepared following the conclusion of the Peer Review process, and will be submitted to USEPA no later than June 30, 2009. Submittal schedules for risk assessment work plans for other Areas will be coordinated with SRI/FS work plan activities for those Areas.

1.2 Risk Assessment Objectives and Overall Process

The ultimate purpose of each Area-specific baseline ERA and HHRA will be to support Area-specific risk management and remedial decision-making.

As described in the SRI/FS AOC and the SOW, the development of the baseline risk assessments will be a collaborative process between KRSG and USEPA, with an opportunity

for the participation of MDEQ. It is anticipated that the parties will meet, confer, and/or exchange information during the process, with the goal of anticipating and resolving key issues during the development of individual risk assessment work plans and reports. The expected outcome of this process is that Area-specific risk assessments will be completed in a timely and efficient manner and that final conclusions of each risk assessment, whether baseline or alternative-specific (see Section 4), will be accepted as having the appropriate technical basis and will be used to support risk management decisions at the Site.

1.3 Constituent of Concern

Based on the Generalized CSM (ARCADIS 2008), PCBs (assessed primarily as total PCBs via SW-846 Method 8082) will be evaluated as the primary constituent of concern (COC) for both the ecological and human health risk assessments. However, data for other constituents such as metals, pesticides, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs) will be collected within each Area to assess the presence and concentrations of contaminants other than PCBs within each Area. Elements of a screening-level assessment, including screening values and/or benchmarks, may be used on an Area-specific basis to focus the assessments by eliminating constituents, exposure pathways, or receptor species for which there is high confidence that there is no or very low Area-specific risk.

1.4 Risk Assessment Framework Organization

Sections 2 and 3 of this document provide information specific to the ecological and human health baseline risk assessment approaches, respectively. Section 4 includes a discussion of the process for evaluating the potential risks associated with each remedial option identified in the Area-specific FS Reports. References are listed in Section 5.

2. Baseline ERA Framework

A baseline ERA will be prepared for each Area in a manner consistent with the provisions of this RA Framework and the USEPA-approved work plan for that Area.

The purpose of each Area-specific baseline ERA will be to determine whether PCBs associated with the Area pose a current or potential risk to ecological receptors in the absence of any remedial action, and if so, to calculate risk-based concentrations for PCBs in relevant environmental media that would result in reduction of potential risks to target levels. The streamlined approach described in Section 1 (i.e., incorporating by reference information, analyses, and conclusions presented in ERAs for Areas previously addressed and for which results have been approved by USEPA) will be employed to the extent possible. In some cases, little or no additional risk assessment work may be completed (as described in Section 1.1).

The following sections present an overview of the existing information and data that will be considered in developing each ERA, and the general approach that will be followed.

2.1 Use of Existing Information and Data

CDM, on behalf of the MDEQ, developed the *Final (Revised) Baseline Ecological Risk Assessment – Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site* (CDM ERA (CDM 2003a). The CDM ERA, which was approved by USEPA, will serve as a point of departure for preparing risk assessment work plans for each Area.

CDM (2003a) incorporated Site-specific soil, sediment, surface water, and biotic tissue data (e.g., fish, plants, soil invertebrates and small mammal tissue) collected in 1993 and 1994. Since that time, substantial Site-specific data have been collected on behalf of KRSG by researchers at MSU under the guidance of Dr. John Giesy. Both the CDM work and the MSU studies provide information that can potentially be used as lines of evidence within a weight of evidence analysis in Area-specific risk assessments.

As described in the SOW and Section 1.1, a Peer Review process is being carried out on the floodplain soils-related ecological studies conducted by MSU. The charge of the Peer Review is to assess the quality and utility of the MSU data for the purpose of refining the assessment of potential ecological risk to floodplain receptors that was presented in the CDM ERA (CDM 2003a). The results of the Peer Review process will also provide information on the utility of the MSU data, methodologies, interpretations, and results for informing risk management decisions and developing the new Area-specific baseline ERAs. The ecological risk assessment portion

of Area-specific risk assessment work plans will be developed based on the outcome of the Peer Review. In addition, if applicable and appropriate, when developing the Area-specific work plans, KRSG may present as additional lines of evidence new ecological information or studies that were not part of the Peer Review.

2.2 General Baseline ERA Process

Each Area-specific baseline ERA will be prepared following a USEPA-approved work plan, which will be based on methodology, science, and USEPA guidance currently accepted or in effect at the time each work plan is prepared.

The USEPA guidance to be followed, unless replaced or superseded by new guidance, includes *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments*, (EPA-540-R-97-006, June 1997), OSWER Directive 9285.7-25, and, as appropriate, the USEPA guidance identified below.

- *Performance of Risk Assessments in Remedial Investigation /Feasibility Studies (RI/FSs) Conducted by Potentially Responsible Parties (PRPs)*. OSWER Directive No. 9835.15. August 28, 1990.

- *Guidance for Data Usability in Risk Assessment (Quick Reference Fact Sheet)*. OSWER 9285.7-05FS. September, 1990.

- *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*. OSWER Directive 9355.0-30. April 22, 1991.

- *Supplemental Guidance on Performing Risk Assessments in Remedial Investigation Feasibility Studies (RI/FSs) Conducted by Potentially Responsible Parties (PRPs)*. OSWER Directive No. 9835.15(a). July 2, 1991.

- *Guidance for Data Usability in Risk Assessment Part A.* Office of Emergency and Remedial Response. Publication 9285.7-09A. April 1992.

- *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F. April 1998.

- *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites*. OSWER Directive 9285.7-28P. October 7, 1999.

- *Guidance for the Data Quality Objectives Process for Hazardous Waste Sites (QA/G-4HW)*. EPA/600/R-00/007. January 2000.

- *Guidance for the Data Quality Objectives Process* (QA-G-4). EPA/600/R-96/055. August 2000.

- *Risk Characterization Handbook*. USEPA Science Policy Council. December 2000.

- *The Role of Screening*-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. OSWER Publication 9345.0-14. EPA/540/F-01/014. June 2001.

- Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. OSWER Directive 9355.0-85. December 2005.

As reflected in the SOW, the KRSG will prepare Area-specific baseline ERAs in accordance with USEPA guidance and, as appropriate, following the guidelines outlined below:

- Hazard Identification (sources). KRSG will review available information on the hazardous substances present at the Area and identify the major COCs.

- Dose-Response Assessment. KRSG will select COCs based on their intrinsic toxicological properties.

- Conceptual Exposure/Pathway Analysis. Critical exposure pathways (e.g., surface water) will be identified and analyzed. The proximity of contaminants to exposure pathways and their potential to migrate into critical exposure pathways will be assessed.

- Characterization of Site and Potential Receptors. KRSG will identify and characterize environmental exposure pathways.

- Selection of Chemicals, Indicator Species, and End Points. In preparing the assessment, the KRSG will select representative chemicals, indicator species (species that are especially sensitive to environmental contaminants), and end points on which to concentrate.

- Exposure Assessment. In the exposure assessment, KRSG will identify the magnitude of actual or environmental exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. The exposure assessment shall include an

evaluation of the likelihood of such exposures occurring and shall provide the basis for the development of acceptable exposure levels. In developing the exposure assessment, the KRSG will develop reasonable maximum estimates of exposure for both current land use conditions and potential land use conditions at the Area.

- Toxicity Assessment/Ecological Effects Assessment. The toxicity and ecological effects assessment will address the types of adverse environmental effects associated with chemical exposures, the relationships between magnitude of exposures and adverse effects, and the related uncertainties for contaminant toxicity.

- Risk Characterization. During risk characterization, KRSG will compare chemical-specific toxicity information, combined with quantitative and qualitative information from the exposure assessment, to measured levels of contaminant exposure levels and the levels predicted through environmental fate and transport modeling. These comparisons will determine whether concentrations of contaminants at or near the Area are affecting or could potentially affect the environment.

- Identification of Limitations/Uncertainties. KRSG will identify critical assumptions (e.g., background concentrations and conditions) and uncertainties in the report.

- Conceptual Model. Based on information developed for the baseline ERA, KRSG will reevaluate/refine the Generalized CSM to develop a conceptual model specific to the Area.

The primary outcomes of the Area-specific baseline ERAs will be 1) the quantification of potential risk of ecological effects occurring if no additional cleanup action is taken there and, if necessary, 2) calculation of risk-based concentrations for PCBs in environmental media that would result in reduction of risk to target levels in consideration of their potential ecological effects.

Specific details regarding data sources or needs, lines of evidence, weighting of lines of evidence, potential receptors or receptor groups, complete exposure pathways, and exposure and risk assessment methodology will be addressed on an Area-specific basis in risk assessment work plans.

3. Baseline HHRA Framework

An Area-specific baseline HHRA will be prepared for each Area in a manner consistent with the provisions of this RA Framework and the USEPA-approved work plan for that Area.

The purpose of each Area-specific baseline HHRA is to determine whether PCBs associated with the Area pose a current or potential risk to human health in the absence of any remedial action, and if so, to calculate risk-based concentrations for PCBs in relevant environmental media that would result in reduction of potential risks to target levels. The streamlined approach described in Section 1 (i.e., incorporating by reference information, analyses, and conclusions presented in HHRAs for Areas previously addressed and for which results have been approved by USEPA) will be employed to the extent possible. In some cases, little or no additional risk assessment work may be completed (as described in Section 1.1).

3.1 Use of Existing Information and Data

CDM's *Final (Revised) Baseline Human Health Risk Assessment – Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site* (CDM HHRA; CDM 2003b), which was developed on behalf of the MDEQ, was issued in May 2003. The CDM HHRA, which was approved by USEPA, will be used as a point of departure for preparing risk assessment work plans for each Area.

Each Area-specific baseline HHRA will be prepared following the USEPA-approved work plan for that Area. The risk assessment work plan will specify details regarding data utilization, methodology, and exposure factor values. As indicated in Section 1.2, to streamline preparation, review, and approval, each Area-specific risk assessment work plan will clearly indicate the aspects of prior USEPA-approved risk assessments that will be revisited. CDM (2003b) incorporated Site-specific soil, sediment, surface water, and fish tissue data collected in 1993. Additional Site-wide and Area-specific data—including both the data that have been collected since 1993 and the new data collected as part of the SRI/FS process—will also be evaluated and incorporated in Area-specific risk assessments as appropriate and as approved for use by USEPA.

3.2 General Baseline HHRA Process

Each Area-specific baseline HHRA will be prepared following a USEPA-approved work plan, which will be based on methodology, science, and USEPA guidance currently accepted or in effect at the time each work plan is prepared.

The USEPA guidance to be followed, unless replaced or superseded by new guidance, for conducting human health risk assessments at Superfund sites includes:

- *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish*: *A Guidance Manual*. EPA-503/8-89-002. September 1989.
- *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* OSWER Directive 9285.6-03. March 25, 1991.
- *Risk Assessment Guidance for Superfund (RAGS), Volume I - Human Health Evaluation Manual (Part A)*, Interim Final. OSWER Directive 9285.7-01A. EPA-540-1-89-002. December 1, 1989.
- *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual*: (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim. OSWER Directive 9285.7-01B. December 1991.
- *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual* (Part C, Risk Evaluation of Remedial Alternatives). OSWER Directive 9285.7-01C. EPA/540/R-92/004. 1992.
- *Guidance on Risk Characterization for Risk Managers and Risk Assessors.* Memo from F. Henry Habicht II, Deputy Administrator, with attachments. February 26, 1992.
- *Guidance for Risk Characterization.* USEPA Science Policy Council. February 1995.
- *Soil Screening Guidance: User's Guide.* Publication 9355.4-23. April 1996.
- *Soil Screening Guidance: Technical Background Document.* OSWER Directive 9355.4-17A. May 1, 1996.
- *Exposure Factors Handbook*, Volumes I, II, and III. EPA/600/P-95/002Fa, b, c. August 1997.
- *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual* (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Interim. OSWER 9285.7-01D. EPA 540-R-97-033. January 1998.

- *Guidance for Conducting Fish and Wildlife Consumption Surveys*. EPA 823-B-98-007. November 1998.

- *Sociodemographic Data Used for Identifying Potentially Highly Exposed Populations.* EPA/600/R-99/060. July 1999.

- *Risk Characterization Handbook.* EPA 100-B-00-002. December 2000.

- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* OSWER Directive 9355.4. March 24, 2001.

- *Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment*. OSWER 9285.7-45. EPA 540-R-02-002. December 2001.

- *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites.* OSWER 9355.0-85. EPA-540-R-05-012. December 2005.

As reflected in the SOW, KRSG will prepare Area-specific baseline Human Health Risk Assessment reports in accordance with USEPA guidance and following the guidelines outlined below:

- Hazard Identification (sources). KRSG will review available information on the hazardous substances present at the Area and identify the major COCs.

- Dose-Response Assessment. KRSG will select COCs based on their intrinsic toxicological properties.

- Conceptual Exposure/Pathway Analysis. KRSG will identify and analyze critical exposure pathways. The proximity of contaminants to exposure pathways and their potential to migrate into critical exposure pathways shall be assessed.

- Characterization of Area and Potential Receptors. KRSG will identify and characterize human populations in the exposure pathways.

- Exposure Assessment. The exposure assessment will identify the magnitude of actual or potential human exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. The exposure assessment will include an evaluation of the likelihood of such exposures occurring and shall provide the basis for the development

of acceptable exposure levels. In developing the exposure assessment, the KRSG will develop reasonable maximum estimates of exposure for both current land use conditions and potential land use conditions at the Area.

- Risk Characterization. During risk characterization, KRSG will compare chemical-specific toxicity information, combined with quantitative and qualitative information from the exposure assessment, to measured levels of contaminant exposure levels and the levels predicted through environmental fate and transport modeling. These comparisons shall determine whether concentrations of contaminants at or near the Area are affecting or could potentially affect human health.

- Identification of Limitations/Uncertainties. KRSG will identify critical assumptions (e.g., background concentrations and conditions) and uncertainties in the report.

- CSM. Based on contaminant identification, exposure assessment, toxicity assessment, and risk characterization, KRSG will reevaluate the preliminary CSM.

The primary outcomes of the Area-specific baseline HHRAs will be 1) the quantification of potential risk of health effects occurring if no additional cleanup action is taken there and, if necessary, 2) calculation of risk-based concentrations for PCBs in environmental media that would result in reduction of risk to target levels in consideration of their potential carcinogenic and non-carcinogenic health effects.

Specific details regarding data sources or needs, potentially exposed populations, complete exposure pathways, and exposure and risk assessment methodology will be addressed on an Area-specific basis in risk assessment work plans.

4. Assessing Risks Associated with Remedial Alternatives

In its *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, USEPA notes that risk assessment for contaminated sediment sites should include an analysis of the risks that may be associated with or introduced by implementation of remedial alternatives (USEPA 2005). Specifically, the Sediment Remediation Guidance notes that short- and long-term risks associated with remedial alternatives should be estimated and considered during remedy selection, and that increases to current risks and the creation of new exposure pathways and risks should be considered (USEPA 2005).

Recognizing that each sediment management approach has its own uncertainties and inherent potential risks, USEPA and the National Research Council (NRC) have both identified comparative net risk reduction as a useful method for ensuring that all positive and negative aspects of each management approach are appropriately considered (USEPA 2005; NRC 2001). Evaluating implementation risk and residual risk in tandem for competing remedial alternatives can provide important insight during the risk management and remedy selection processes (USEPA 2005).

Consistent with relevant guidance (USEPA 1999, 2005; NRC 2001, 2007), this RA Framework provides for a variety of factors to be considered in the evaluation of alternative-specific risks, as described below. These factors will be considered in the Area-specific FS reports, which will include a separate comprehensive evaluation of the potential risks and relative risk reduction associated with each of the identified remedial alternatives. If relevant new guidance or information becomes available during preparation of Area-specific FS reports, it will be considered and incorporated into the evaluations.

- **Short-term risks due to constituent mobilization.** Remediation activities may result in the mobilization of contaminants. For example, dredging equipment disturbs sediment and resuspends some fraction of it in the water column. A portion of this material will settle in the area of removal. However, finer-grained materials, and the constituents bonded to them, can remain in the water column and may be transported to other locations. In addition, dissolved contaminants may also be released. This remobilization can result in impacts to downstream or adjacent areas. The potential for mobilization of contaminants will be evaluated based on consideration of Site-specific physicochemical properties (e.g., grain size, total organic carbon, spatial and vertical distribution of contaminants), Site conditions (e.g., water velocity, salinity, debris, weather, changes in water elevation, substrate, etc.), the equipment proposed to be used, and observational data from work in other Areas of the river. Per USEPA (2005) guidance, mobilization related to remedial

activities will be evaluated in the context of potential releases in the absence of remedial action.

- **Risks associated with residual (post-remediation) exposure.** Regardless of the remedial alternative selected, there is likely to be residual exposure to contaminants in the remediation area after implementation. Residual contamination can be due to the remobilization of chemicals during implementation of the remedy or as the result of material that is remaining following removal. Residual exposure is an important determinant of net risk reduction.

- **Risks associated with transportation.** Remedial alternatives that include moving dredged material to offsite disposal facilities and/or moving clean fill (e.g., sand and gravel) onsite for berm and capping operations present transportation-related risks to workers and the public. These risks can be estimated for both the occupants of the transportation vehicle (e.g., truck driver, railroad conductor) as well as non-occupants that may be involved in a transportation-related accident. In addition, there are additional potential community impacts (e.g., accidents, noise, residential or commercial disruption). These risks increase with the number of trips each vehicle makes and each mile the material is transported, and also varies with the specifics of each implementation plan.

- **Risks associated with disposal.** Disposal refers to the placement of dredged or excavated material and process wastes into a structure, site, or facility designed to receive these materials. All disposal alternatives result in some potential risk either from routine practices or from unintended events such as transportation accidents or releases of material at the disposal site. In addition, when disposing of sediments, volatilization of chemicals may occur. Longer-term risks from disposal depend on the characteristics of the containment and the design and maintenance of the facility. For example, such facilities should be designed to prevent or minimize the migration of contaminants into groundwater.

- **Habitat alterations/loss.** Remedies that involve water level modification, capping, or removal of sediment or soil will inevitably result in the alteration or potential loss of habitat for a variety of species. These activities can dramatically alter the available substrate and cover, channel width, or flow conditions, affecting sustainability of the existing communities. Often, this loss is temporary, and the ecological community is able to recover over time. However, if the area affected is extensive or if sensitive communities or habitats are removed, the impact can be long-lasting. For example, it would take decades to restore a mature hardwood forest and a period after that for the ecological communities that rely on that habitat to completely recover. Therefore, when comparing the identified alternatives, consideration will be given to the possible impacts of habitat loss.

This consideration is consistent with USEPA guidance (USEPA 1999), which states that "even though an ecological risk assessment may demonstrate that adverse ecological effects have occurred or are expected to occur, it may not be in the best interest of the overall environment to actively remediate the site. At some sites, especially those that have rare or very sensitive habitats, removal or in-situ treatment of the contamination may cause more long-term ecological harm (often due to widespread physical destruction of habitat) than leaving it in place." Procedures for assessing habitat quality will be developed collaboratively with stakeholders.

- **Worker risks associated with implementation of the remedy.** The implementation of many remedial alternatives poses some potential risk of fatal and non-fatal injury to workers. For example, alternatives such as capping and dredging require the use of heavy construction equipment such as dredges and cranes, as well as boats, winches, etc. Occupational risks generally increase in proportion to the size of the project (i.e., the volume of material removed or clean fill material added). These risks can be estimated based on national statistics for occupational fatalities and injuries.

- **Community/societal impacts.** The National Research Council's *A Risk-Management Strategy for PCB-Contaminated Sediments* report (NRC 2001) suggests that evaluation of remedial alternatives should also consider a broader array of risks to include potential societal, cultural, and economic risks. For example, as noted above, offsite disposal of material can result in a risk of increased accidents, noise pollution, and residential or commercial disruption. These impacts can be difficult to quantify. However, they play an important role in risk management decisions.

The specific alternatives for evaluating potential ecological and human health impacts associated with remedial options will be included in each Area-specific SRI/FS work plan. A thorough evaluation of each alternative, including both the benefits and risk, will ensure that the net reduction in risk for both humans and the environment is understood in the remedy selection process as recommended by USEPA guidance (USEPA 1999, 2005) and the National Research Council (2001, 2007).

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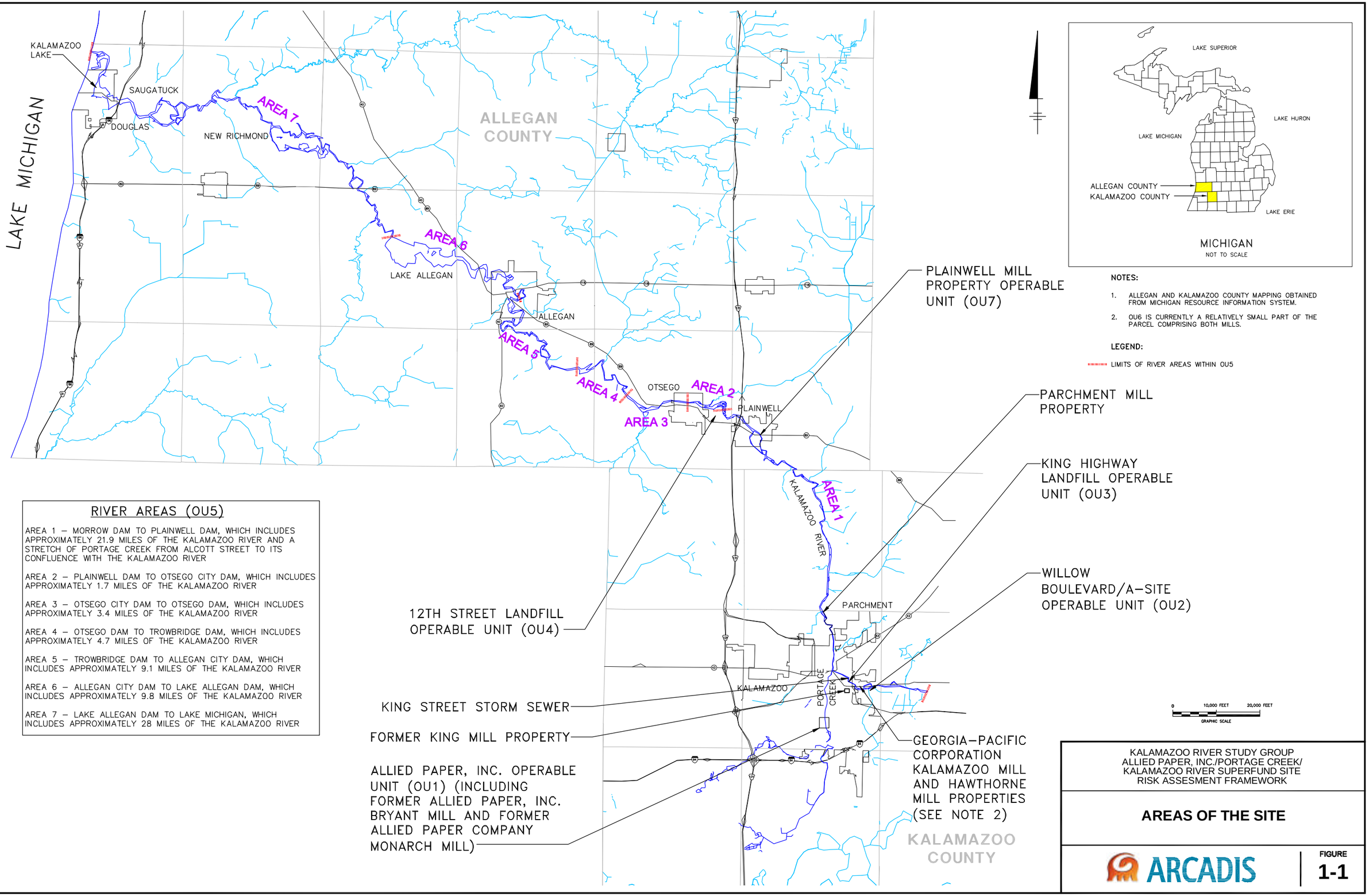
Figure



RIVER AREAS (OU5)

AREA 1 – MORROW DAM TO PLAINWELL DAM, WHICH INCLUDES APPROXIMATELY 21.9 MILES OF THE KALAMAZOO RIVER AND A STRETCH OF PORTAGE CREEK FROM ALCOTT STREET TO ITS CONFLUENCE WITH THE KALAMAZOO RIVER

AREA 2 – PLAINWELL DAM TO OTSEGO CITY DAM, WHICH INCLUDES APPROXIMATELY 1.7 MILES OF THE KALAMAZOO RIVER

AREA 3 – OTSEGO CITY DAM TO OTSEGO DAM, WHICH INCLUDES APPROXIMATELY 3.4 MILES OF THE KALAMAZOO RIVER

AREA 4 – OTSEGO DAM TO TROWBRIDGE DAM, WHICH INCLUDES APPROXIMATELY 4.7 MILES OF THE KALAMAZOO RIVER

AREA 5 – TROWBRIDGE DAM TO ALLEGAN CITY DAM, WHICH INCLUDES APPROXIMATELY 9.1 MILES OF THE KALAMAZOO RIVER

AREA 6 – ALLEGAN CITY DAM TO LAKE ALLEGAN DAM, WHICH INCLUDES APPROXIMATELY 9.8 MILES OF THE KALAMAZOO RIVER

AREA 7 – LAKE ALLEGAN DAM TO LAKE MICHIGAN, WHICH INCLUDES APPROXIMATELY 28 MILES OF THE KALAMAZOO RIVER

NOTES:

1. ALLEGAN AND KALAMAZOO COUNTY MAPPING OBTAINED FROM MICHIGAN RESOURCE INFORMATION SYSTEM.
2. OU6 IS CURRENTLY A RELATIVELY SMALL PART OF THE PARCEL COMPRISING BOTH MILLS.

LEGEND:

LIMITS OF RIVER AREAS WITHIN OU5

KALAMAZOO RIVER STUDY GROUP
ALLIED PAPER, INC./PORTAGE CREEK/
KALAMAZOO RIVER SUPERFUND SITE
RISK ASSESMENT FRAMEWORK

AREAS OF THE SITE

ARCADIS

FIGURE 1-1